Digital Image Processing On Kaffir Orange Peel With Canny Edge Detection Algorithm

Nurul Azmi Syahfitri¹, Achmad Fauzi ², Milli Alfhi Syahri³

¹,²,³STMIK Kaputama

nurulazmi1907@gmail.com¹; fauzie.kaputama@gmail.com²; milli.fhisya@gmail.com³;

Abstract

Object tracking is a form of application of computer vision. To be able to track an object, a stage is needed in the image processing process. Image processing is a field related to the process of image transformation (image). The image processing process is carried out to obtain better image quality. The harvesting system in kaffir lime is done manually, by choosing fruits whose skin color is green, and not yellowish. Due to the small and asymmetrical size and shape of kaffir lime, manual harvesting systems are still widely used to maintain the quality and quantity of the harvest. In addition, the manual harvesting system can also avoid damage to kaffir lime trees and obtain optimally ripe kaffir limes. Kaffir lime also has genders like humans, namely males and females. In male kaffir lime there is a circle that is more prominent in size underneath, while female kaffir lime has a flat shape. However, for consumption and medicinal purposes both male and female kaffir lime can be used without affecting the taste or quality of the fruit. With the image processing to determine the level of wrinkles on quality kaffir lime peel, kaffir lime will be selected which is usually used for herbal medicines. In this case, the Canny Edge Detection algorithm can be used to identify density edges in kaffir lime peels. Thus, the degree of wrinkles in kaffir lime peel can be calculated and measured to be more accurate. And can be separated quality or non-quality kaffir lime with the image of kaffir lime that has been seen through the image.

The results obtained in designing and analyzing the quality of kaffir lime are clearer and more accurate with an image resolution value of 248 x 216 that the orange is included in the female kaffir lime type. The results tested that the right edge detection method in carrying out the edge detection process in the image of kaffir lime peel is the Canny Edge Detection Algorithm. By using the image on the Canny Edge Detection Algorithm, more dense and quality kaffir lime results are obtained so that it can be used for herbal medicine.

Keywords: Digital Image, Kaffir lime, Canny edge detection algorithm

1. Introduction

Digital images are obtained from a set of images and videos. Along with the development of technology, now digital image processing techniques will be developed into computer vision. Computer vision is a science that uses image processing to make decisions based on images obtained from sensors. Computer vision and human vision have the same function, with the aim of interpreting spatial data that is data that is indexed more than one dimension. Computer vision techniques can precisely replicate the function of the human eye and improve the human vision system [9]. Object tracking is a form of application of computer vision. To be able to track an object, a stage is needed in the image processing process. Image Processing is a field related to the process of image transformation (image). The image processing process is carried out to obtain better image quality. The harvesting system in kaffir lime is done manually, by choosing fruits whose skin color is green, and not yellowish. Due to the small and asymmetrical size and shape of kaffir lime, manual harvesting systems are still widely used to maintain the quality and quantity of the harvest. In addition, the manual harvesting system can also avoid damage to kaffir lime trees and obtain optimally ripe kaffir limes. Kaffir lime also has genders like humans, namely males and females. In male kaffir lime there is a circle that is more prominent in size underneath, while female kaffir lime has a flat shape. However, for consumption and medicinal purposes both male and female kaffir lime can be used without affecting the taste or quality of the fruit. With the image processing to determine the level of wrinkles on quality kaffir lime peel, kaffir lime will be selected which is usually used for herbal medicines. In this case, the Canny Edge Detection algorithm can be used to identify density edges in kaffir lime peels. Thus, the degree of wrinkles in kaffir lime peel can be calculated and measured to be more accurate. And can be separated quality or non-quality kaffir lime with the image of kaffir lime that has been seen through the image.
2. Research Methods

2.1 Previous Research

Previous research aims to obtain comparison and reference materials. In addition, to avoid presuming similarities with this study. So in this literature review researchers include the results of previous research as follows: The first study was entitled "Comparison of Sobel, Prewitt, Robert and Canny Methods on Edge Detection of Moving Objects". Research with the discussion of computer vision is a field of science from image processing [3]. To be able to recognize shapes, an initial stage in image processing is needed, namely edge detection. The object used in tracking in computer vision is a moving object (video). Edge detection is used to recognize the edges of objects and reduce noise. The edge detection algorithms used in the study were Sobel, Prewitt, Robert and Canny. Tests were conducted on three videos taken from the Matlab library. Testing is carried out using the Simulik Matlab tool. The results of edges and overlay testing show that the Prewitt Algorithm has better edge detection results compared to other algorithms. The Prewitt algorithm produces edges that are smoother and clearer like real objects. Canny's algorithm did not succeed in generating edges on video objects. Sobel and Robert's algorithm can detect edges but it is not as obvious as Prewitt because there are some missing edges. [11]

2.2 Digital Image Processing

Digital image processing is a field of science that studies how an image is formed, processed, and analyzed so as to produce information that can be understood by humans, while an image histogram is a graphic representation that expresses the distribution of color values or the intensity of pixels in the image. (Digital Image Processing) is a scientific discipline that studies techniques in processing images, the image in question is a still image (photo) or moving image (such as recorded video). While the meaning of digital is image processing / images carried out using a computer digitally.[1] RGB stands for Red-Green-Blue, are three basic colors (primary colors) which are generally used as a reference to other colors from the RGB base, we can convert colors into number codes that make the color will appear universal. The computer has packaged the color information into the same color model so that RGB color processing can be done easily.[12] An image can be defined as a two-dimensional function, f(x, y) where x and y are the flat-plane coordinates, and the value of the function f in each pair of coordinates (x, y) is called the intensity or grayscale level of the image at that point. If x, y and f are all finite (finite) and the values are discrete, then the image is called a digital image. A digital image consists of a finite number of elements, each of which has a specific location and value. A digital image can be represented by a matrix consisting of M columns of N rows, where the intersection between columns and rows is called pixel (pixel = picture element), i.e. the smallest element of an image. Pixels have two parameters, namely coordinates and pixel intensity are the basic building blocks of a digital image. [5]

2.3 Kaffir Lime

Kaffir lime (Citrus hystrix) is a type of shrub plant that has many benefits, especially the fruit and leaves. Besides being used for flavoring dishes, citrus hystrix has benefits for body health and facial beauty. [10] Kaffir lime leaf extract has organoleptic characteristics such as viscous form there is a layer of oil on the surface, blackish-green color, characteristic smell of kaffir lime leaves, kaffir lime leaf powder that has been tested for moisture content in the extract by maceration or soaking method. The filter solution used is n-hexane because it has good non-polar properties in attracting terpenoid compounds which are non-polar compounds. N-hexane is a type of non-polar solvent that can be used to extract non-polar compounds such as essential oils and derivatives. The results of extracting 300 gr of kaffir lime leaf powder produced an extract of 23.56 gr with a yield calculation of 7.85%, the yield calculation results were relatively small because n-hexane was more selective in dissolving compounds in kaffir lime leaves, namely only non-polar compounds. The oil layer on the surface of the viscous extract indicates that n-hexane can attract essential oil-derived compounds contained in kaffir lime leaves. The results of organoleptic testing of lime leaf extract lotion preparations are green, smell typical of kaffir lime leaves and have a semi-solid and thick texture. Purut lime leaf extract after testing obtained a dark red color while kaffir lime leaf lotion obtained a brick red color. The difference in color obtained is caused by differences in the amount of terpenoid content. The change in color from dark red to brick red means a slight reduction in the terpenoid content of kaffir lime leaf extract to a lotion preparation. This happens because of the influence of adding ingredients and in the manufacturing process to become a preparation of kaffir lime leaf extract lotion. [8]

The following is one example of a kaffir lime image listed below:

![Fig. 1: Kaffir Lime](image-url)
2.4 Canny Edge Detection Algorithm

Canny Edge Detection algorithm is an image processing technique to detect edges in images. This algorithm combines several steps such as smoothing, gradient calculation, non-maximum suppression, and hysteresis to produce accurate and sharp edges in the image. This helps identify the boundaries of objects and separate them from the background in the image. The difference from other algorithms is that Sobel is an edge detection method included in the gradient edge detector. Prewitt has a gradient equation with Sobel but with a constant value equal to 1. Robert is also called the cross operator because of the x direction and the diagonal y direction in quadrant 1. [9]

Operators using 2 kernels of 16 x 16 (Kx and Ky) and magnitude gradient (G) with equations (1), (2), (3). The steps for calculating the Canny Edge Detection Algorithm are below:

1. When the image is smoothed out, the derivatives Ix and Iy wrt x and y are calculated. This can be implemented by combining I with the Canny kernels Kx and Ky, with equations (2.1) and (2.2):

   \[ K_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \]  

   \[ K_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \]  

   (1)

   (2)

   **Definition 2.1:** Canny filter for both directions (horizontal and vertical)

2. Then, the magnitude G and slope θ of the gradient are calculated by equation (2.3):

   \[ G = \sqrt{G_x^2 + G_y^2} \]  

   (3)

   **Definition 2.2:** Gradient intensity and edge direction

Determining the Thresholding Value Using the Equation (2.4)

\[ g(x, y) = \begin{cases} 1 & \text{if } f(x, y) > 128 \\ 0 & \text{if } f(x, y) < 128 \end{cases} \]  

(4)

**Definition 2.3:** By checking the number if the number value is >128 then the given binary value is 1, if the number value is <128 then the given binary value is 0 [4].

2.5 MATLAB

MATLAB (Matrix Laboratory) is a program for numerical analysis and computation and is an advanced mathematical programming language formed on the basis of thinking using matrix properties and shapes. Initially, the program was an interface for the collection of numeric routines from the LINPACK and EISPACK projects, and was developed using the FORTRAN language but is now a commercial product of the company Mathworks, Inc. which in later developments was developed using the C++ language and assembler (mainly for basic MATLAB functions). MATLAB has evolved into a sophisticated programming environment that contains built-in functions for performing signal processing, linear algebra, and other mathematical calculations. MATLAB also contains a toolbox that contains additional functions for specific applications. MATLAB is extensible, in the sense that a user can write new functions to add to a library when the built-in functions available cannot perform a specific task. The programming skills needed are not too difficult if you already have experience in programming other languages such as C++, Pascal, or FORTRAN.

MATLAB is a brand of software developed by Mathworks, Inc. Mathworks is the most efficient software for matrix-based numeric calculations. Thus, if in calculations we can formulate problems into matrix format, then MATLAB is the best software for numerical solutions. MATLAB which is a high-level programming language based on matrices is often used for numerical computational techniques, to solve problems involving mathematical operations of elements, matrices, optimization, approximation and others [2].

3. Results And Discussion

3.1 Research Methods

The research method in writing this final project was carried out at the Stabat Traditional Market at local flower traders using the interview method. Research on this thesis follows the methodological stages in research, which are as follows:

To clarify the structure of the research methodology above, the author makes the following explanation:
1. Identify the Problem
   This stage is the initial stage used to identify problems with the aim of observing and looking for problems that are being faced in the object of research, namely looking for the quality of lime density based on the image of edge texture.

2. Gathering Supporting Theories
   Collection of theories related to the subject matter such as theories about image processing, methods used and application design of the required system. In this stage, theories are gathered from several sources such as books, journals, articles and other references.

3. Method Testing
   At this stage, researchers will test the methods used in the process of quality image capture techniques with existing guidance on image theories from books and journals related to the subject matter.

4. System Designer
   At this stage, system design is carried out on the problem being studied, it can be a stage to design the workflow of the system and also design the display aspect of the system.

5. Method Implementation
   Implement methods that have been tested previously with the design of the system that has been made and code according to the programming language used to create the system.

6. System Testing
   In the final stage, a series of tests are carried out on the system that has been made, testing is carried out in order to find errors in the system and make the necessary improvements.

3.2 Research Supporting Data

Kaffir lime has two different types, namely male and female kaffir orange. One of the differences is the level of acidity, where male kaffir limes tend to be more acidic than female kaffir oranges. To distinguish the two, it can be seen from the size of the small circle under the orange, if the circle is large (looks flat) then it is a female kaffir orange, while if the circle is small and more prominent it is a male kaffir orange. In addition, the skin of male kaffir lime is noticeably harder compared to female kaffir lime which is softer. Here is the supporting data, namely kaffir lime seen in Figure.

![Fig. 2: Image of Male Kaffir Lime](image)

![Fig. 3: Image of Female Kaffir Lime](image)

3.3 Application of the Method

One of the edge detection operators is the canny edge detection developed by John F. Canny. There are several most optimal edge detection criteria with the Canny Algorithm well detecting (detection criteria) the ability to lay and mark all existing edges according to the selection of convolution parameters performed. At the same time, it also provides very high flexibility in terms of determining the level of edge thickness detection as desired. The Canny algorithm is an edge detection algorithm performed with a convolution approach to image matrix functions and Gaussian operators. Canny Edge Detection was developed by John F. Canny in 1986 and uses a phased algorithm to detect various edges in an image.[4]

3.4 Algorithm Analysis

Based on the observations that have been made, edge detection to measure the density of wrinkles in kaffir lime through the peel. Looking at the lime peel, there are more wrinkles that will be explained in figure 3.
2. **Matrix Convolution**

Matrix convolution is the process of converting an image into a matrix number to obtain that image into a number. Makes it easy to calculate blocks with pixel size on the Canny Algorithm. Here is a picture that has a black and white image on kaffir orange. To carry out the edge calculation process, the image is converted into black and white. The black and white image of kaffir lime can be seen in Figure 5 as follows:

![Black and White Image of Kaffir Lime](image)

The following convoluti results convert the image image into numbers below which will be used as a calculation of the Canny Edge Detection method:

```
177  160  135  115  116  127  133  131  123  130  138  135  125  128  137  161  188  198  149  127  108  109
123  129  127  125  124  136  146  146  139  135  150  167  138  123  117  121  131  158  186  196  116  105  105  116  123  124  125  131
132  142  148  149  150  149  161  178  162  139  124  122  128  152  161  164  194  220  221  211  191  191  195  194  184  199  180  181  182  184  194  195  177
155  140  130  124  120  133  134  120  112  125  148  161  164  194  220  211  191  191  195  183  180  184  189  182  166  151  141  134
123  134  134  119  109  121  145  161  177  204  227  211  186  188  205  206  176  173  182  189  182  168  158  153  129  128  117
113  128  156  175  199  218  228  201  168  172  202  216  180  167  176  195  196  185  177  173  125  126  123  121  130  152  179  198
221  232  233  200  164  194  210  187  167  175  199  205  198  194  191  136  131  127  137  159  183  202  213  227  235  237  211
178  174  191  196  189  166  175  201  209  208  207  201  156  145  143  162  191  211  216  214  216  222  229  217  194  186  190  185
182  165  178  205  215  218  217  206  172  158  156  180  213  228  221  208  201  205  215  212  199  192  190  179  173  161  178  206
217  222  221  206  163  164  169  195  221  218  198  189  183  194  210  210  198  189  177  158  150  153  186  212  214  222  213  176
158  164  176  196  209  201  186  184  193  199  208  203  188  179  171  154  151  162  197  215  204  201  192  164  153  168  184  197
196  183  175  183  196  198  204  198  182  174  168  156  156  156  173  202  207  189  180  173  155  157  172  189  195  184  171  173  187
188  189  199  197  184  176  171  161  161  172  185  185  176  172  165  163  167  171  183  187  174  165  173  188  175  177  190  194
182  172  166  157  156  161  163  166  178  180  165  151  164  164  171  174  164  159  167  179  165  164  176  182  171  160  157  150
156  162  160  168  193  193  165  146  161  158  163  168  157  152  159  165  156  150  163  155  150  156  157  175  187  182  185
207  200  167  151  158  154  161  167  155  148  151  154  149  140  144  149  145  148  162  171  196  214  207  200
```

3. **Canny Edge Detection Method Calculation**

Dividing the image into 16 x 16 pixels to adjust to Canny, then the size of the processed image will be broken into blocks with a size of 16 x 16 pixels per block as in Figures 6 and Figure 7:

![16 x 16 Image](image)
Define the Canny Edge Detection Kx and Ky operators using a matrix of Canny Edge Detection Kx and Ky operators to perform edge detection.

These pixel values will be processed with the Canny Edge Detection method to detect edges in the image. The pixel values of the above images are processed according to the provisions of the Canny Edge Detection method. Convolution grayscale images with horizontal Canny Edge Detection kernel (Kx) and vertical Canny Edge Detection kernel (Ky).

Determining the gradient value of a gray image that has been operated with a matrix mask via Canny Edge Detection is seen in Figure 7.

$$K_x = \begin{pmatrix}
116 & 123 & 124 & 125 & 131 & 132 & 142 & 148 & 149 & 150 & 149 & 161 & 178 & 162 & 139 & 124 \\
128 & 152 & 174 & 180 & 100 & 105 & 115 & 122 & 125 & 129 & 139 & 147 & 145 & 149 & 149 & 153 \\
161 & 167 & 179 & 190 & 164 & 144 & 135 & 155 & 147 & 157 & 154 & 100 & 114 & 121 & 122 & 129 \\
159 & 162 & 157 & 158 & 155 & 158 & 170 & 171 & 173 & 179 & 210 & 183 & 162 & 150 & 143 & 146 \\
184 & 194 & 195 & 177 & 155 & 140 & 130 & 124 & 120 & 133 & 124 & 120 & 112 & 125 & 148 & 161 \\
194 & 220 & 211 & 191 & 191 & 195 & 183 & 180 & 184 & 189 & 182 & 166 & 151 & 141 & 134 & 123 \\
196 & 189 & 166 & 175 & 201 & 209 & 208 & 207 & 201 & 156 & 145 & 143 & 162 & 191 & 211 & 216 \\
\end{pmatrix}

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The pixel value obtained from the calculation of pixels operated by the Canny Edge detection method at the point of row 1, column 1 is 2.998.

$K_x = (177)(-1) + (117)(-2) + (146)(-1) + (160)(0) + (120)(0) + (146)(0) + (135)(1) + (128)(2) + (139)(1) = -27$

$K_y = (177)(1) + (160)(2) + (135)(1) + (117)(0) + (120)(0) + (128)(0) + (146)(-1) + (146)(-2) + (139)(-1) = 55$

$K[f(x,y)] = \sqrt{-27^2 + 55^2} = 2.998$

The pixel value obtained from the calculation of pixels operated with Canny Edge Detection at the point of row 1, column 13 is 37,958.

$K_x = (121)(-1) + (127)(-2) + (196)(-1) + (134)(0) + (125)(0) + (116)(0) + (149)(1) + (124)(2) + (105)(1) = -69$

$K_y = (121)(1) + (134)(2) + (149)(1) + (127)(0) + (125)(0) + (124)(0) + (196)(-1) + (116)(-2) + (105)(-1) = 5$

$K[f(x,y)] = \sqrt{-69^2 + 5^2} = -44$

The pixel value obtained from the calculation of pixels operated with Canny Edge Detection at the point of row 1, column 14 is -44

The final calculation is the pixel calculation process that continues to completion.

Determining the Thresholding Value

If $f(x,y) \geq 128$

$g(x,y) = 1$

If $0 \leq f(x,y) < 128$

$g(x,y) = 0$

Then the binary values given for the numbers 2998, 174, 6142, 16530, 14240, 1576, -144, 756, 954, 72, 10484, 50208, 37958, -44 are 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1.
### Table 2: Grayscale Image Results

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### Table 3: Binner Calculation Results

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The result of the calculation above is a binner image with the number 0 is the color that shows black and the number 1 image is the color that shows white. Shows the image as a result of the black and white image process.

### 3.5 Interface Discussion

The explanation of the interface design that has been made by research with edge detection canny algorithm which has results to see the results of the lime peel detection image program conducted by the study. The following is a discussion of interface design on image systems:

1. **Main Display Form**
   Edge detection is the main display of the application that has been built and designed so that researchers can provide programmatic simulation information from canny edge detection images. This figure connects users to be able to use edge detection applications with the edge detection canny algorithm. This figure is implemented with the figure in Figure 10.

![Fig. 7: Image Program](image-url)
The explanation of the image above is the result of a program that will have been designed by research to facilitate the results of presenting the desired image results. The program explanation steps above will be explained below:

1. Open Image displays image data with images taken that will be converted into numbers.
2. Upload Image retrieves the same image image data as the image displays image data.
3. RGB to Gray displays the image to black and white.
4. Convert to Binary Image converts images to twinkle numbers.
5. Reset if you want the image to be replaced to clean up the layer.
6. To analyze the image results, press the edge detection algorithm canny.
7. The results will appear on the program screen.

4. Conclusions

After doing the explanation in the previous chapter. Then the researcher will provide some conclusions on the results of the program made. The following are the conclusions of research related to kaffir lime peel image processing techniques based on texture images using the Canny Edge Detection Algorithm:

1. The results obtained in designing and analyzing the quality of kaffir lime are clearer and more accurate with an image resolution value of 248 x 216 that the orange is included in the female kaffir lime type.
2. The results tested that the right edge detection method in carrying out the edge detection process in the image of kaffir lime peel is the Canny Edge Detection Algorithm.
3. The results of MATLAB 2014 programming with images obtained the texture of the edges of kaffir lime peel with more wrinkles and denser using the Canny Edge Detection Algorithm.
4. By using the image on the Canny Edge Detection Algorithm, more dense and quality kaffir lime results are obtained so that it can be used for herbal medicine.

References